The Science of Behavior Change : The Road Ahead

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46 The Science of Behavior Change: The Road Ahead

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46.1 Introduction

The Handbook of Behavior Change adopts a theory- and evidence-based approach to scientific inquiry into, and the practice of, behavior change. Drawing from multiple disciplines and perspectives, the handbook provides comprehensive coverage of topics in three parts: Part I covers a selection of the most prominent theories that have been commonly applied to explain behavior change;[1] Part II reviews models and processes that have been adopted to develop behavior change interventions and the methodological and pragmatic considerations that need to be accounted for when implementing and evaluating them; and Part III provides the evidence base, specific guidelines and considerations, and steps for developing and implementing behavior change interventions using particular approaches. Although the science of behavior change is a relatively new discipline, the handbook illustrates the intense interest, breadth of approaches, and complexity of issues and considerations that need to be accounted for when seeking to understand and change behavior.

An "at a glance" summary of the key contributions to behavior change covered in the handbook is provided in Table 46.1 under five global themes: (1) individual approaches to behavior change; (2) social, ecological, and environmental perspectives on behavior change; (3) behavior change interventions: development, implementation, and evaluation; (4) considerations in developing behavior change interventions; and (5) innovative methods in behavior change. Each global theme is organized into several subthemes that reflect major contributions in each area. Chapters relating to each subtheme along with further relevant articles and sources, key concepts and theories or models, and a summary of its significance for behavior change are also identified.

Aside from summarizing the current state-of-the-art in the science of behavior change, the handbook also aims to advance research on, and understanding of, behavior change. In keeping with this goal, this chapter identifies some emerging areas of behavior change that represent important topics going forward and outlines some priority questions and recommendations that will set the agenda for future research. The chapter is organized into three sections: trends, gaps, and issues in the development of behavior change theory; issues in intervention development; and suggestions for "best-practice" guidelines for behavior change.

46.2 Development of Theory on Behavior Change: Trends, Gaps, and Ongoing Issues

46.2.1 Moving on from Individual Approaches to Behavior Change

Keen observers will note the striking preponderance of individual approaches to behavior among

[1] For a comprehensive list and basic description of theories that have been applied to understand behavior change, the reader is directed to Michie, West, Campbell, Brown, and Gainforth's (2014) book on the subject.
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Table 46.1 Themes emerging from the handbook with source chapters and further reading, key concepts, and a summary of the significance of each theme for behavior change

Global Theme	Theme	Key Chapters and Citations	Key Concepts/Theories	Significance for Behavior Change
Individual approaches to behavior change	Social cognition theories	Chapters 2, 3, 4, 5, 10, 15, 31, 32, 34; Ajzen (1991); Bandura (1986); Leventhal et al. (1980); Rogers (1975); Rosenstock (1974)	Concepts: information processing; attitudes; beliefs; aelf-efficacy; anticipated affect; risk perceptions Theories/models: social cognitive theory; theories of reasoned action and planned behavior; health belief model; protection motivation theory; common sense model	Identification of belief- and attitude-based determinants of behavior and behavior change techniques aimed at changing beliefs (e.g., information provision and persuasion, experiences of success, positive feedback, fear appeals)
	Dual-phase approaches and action planning	Chapters 6, 7, 15, 39; Heckhausen & Gollwitzer (1987); Schwarzer (2008)	Concepts: motivational vs. volitional phases; implementation intentions; implemental mindsets Action and coping planning Theories/models: model of action phases; health action process approach; integrated theories	Resolving limitation of weak intention-behavior relations by specifying separate motivational and volitional phases of action; planning constructs identified as key means convert intentions into action; effectiveness of interventions including planning techniques such as implementation intentions, and action and coping planning
	Implicit/automatic processes	Chapters 12, 13, 14, 15, 34, 36, 41, 42; Gibbons et al. (1998); Hagger & Chatzisarantis (2014); Montaño & Kasprzyk (2015); Strack & Deutsch (2004); Thaler & Sunstein, 2008; Triandis (1977)	Concepts: reflective-impulsive determinants (system 1 vs. system 2); habits; automaticity; implicit processes Theories/models: prototype willingness model; integrated behavioral model; integrated behavior change model	Recognition of nonconscious, automatic determinants of behavior; Utilization of strategies targeting those who are highly vulnerable to impulses temptations or strong maladaptive habits (e.g., environmental restructuring, nudging), and promoting adaptive habits (e.g., repeated experience, cue awareness)

Continued

	General theories of motivation and individual differences	Chapters 8, 9, 11, 15, 33, 35, 37, 38, 40, 45; Deci & Ryan (1985); Hofmann & Kotabe (2012); Locke & Latham (2019)	Concepts: incentives; intrinsic vs extrinsic motivation; motivational quality; self-control Theories/models: self-determination theory; integrated self-control theory; goal setting theory	General theories of motivation that focus on quantity of motivation – such as incentives and rewards – can be powerful influences on behavior; goals also scaffold motivation, particularly goals with personal relevance and SMART features; motivational quality (e.g., intrinsic and self-determined motivation) can be important for persistence; individual differences in capacities to self-regulate (e.g., self-control) promote general motivation toward behaviors
Social, ecological, and environmental perspectives on behavior change	Ecological and community approaches to behavior change	Chapters 17, 18, 28; Bandura (1986); Bronfenbrenner (1977); McLeroy et al. (1988)	Concepts: multiple levels of influence; collective efficacy; interpersonal contact; community and coalition building; social capital – bonding, bridging, linking; social norms; community consciousness Theories/models: ecological systems theory; social cognitive theory; social ecological model; systems theory; theories of power; empowerment theories; social network/social support theories; theories of stigma and discrimination; diffusion of innovations theory; organizational development and change theories; social norms theories; theories of power and process; coalition frameworks; social capital and community capacity	Behavior is determined by influences from multiple levels within society: policy, community, organizational, social, and individual; accounting for influences at each level is central to providing a comprehensive description of behavioral determinants. Changing behavior within community contexts requires consideration of social norms, social settings, and social policy

Continued

Table 46.1 (Cont.)

Global Theme	Theme	Key Chapters and Citations	Key Concepts/Theories	Significance for Behavior Change
			theories; conscientization; community organization; multiplex policy networks	
	Environment and behavioral economic approaches	Chapters 14, 41, 42; Thaler & Sunstein (2008); Kahneman (2011); Daw et al. (2011)	Concepts: incentives; rewards; choice architecture; nudge; heuristics and biases Theories/models: economic theory; incentive theory; "model-based" vs. "model-free" framework	Rewards and incentives are effective environmental contingencies that motivate behavior change based on classic economic models. Nudge and choice architecture interventions promote behavior change by restructuring the environment at the point of decision-making without limiting choice
	Social and group-based approaches	Chapters 16, 43, 44; Tajfel & Turner (1986); Turner et al. (1987); Jetten et al. (2012)	Concepts: group norms; social identity; group identification Theories/models: social identity theory; self-categorization theory; social identity model of behavior change; social "cure"	Individuals' behavior is a function of their identification with the groups to which they belong and the extent to which they self-categorize themselves as typical members of the group; Individuals identifying with groups will behave consistently with norms, which can be manipulated and leveraged to change behavior
Behavior change interventions: development, implementation, and evaluation	Approaches to behavior change intervention development	Chapters 19, 20, 21; Abraham (2012), Bartholomew Eldredge et al. (2016); Sheeran et al. (2017); Presseau et al. (2019); Michie, van	Concepts: mechanisms of action; logic model; behavior change techniques Theories/models: intervention mapping; behavior change wheel; theoretical domains framework	Provides researchers and intervention designers with steps to intervention development beginning with problem identification, identification of techniques and mechanisms of change, consideration of design elements, and implementation components

Continued

		Straalen, & West (2011)		
	Evaluation of behavior change interventions	Chapters 22, 46; Glasgow et al. (2019); Skivington et al. (2019)	Concepts: types of evaluation; program theory; implementation science; economic evaluation Theories/models: RE-AIM framework; UK Medical Research Council's (MRC) guidance on complex interventions	Different approaches to behavioral intervention evaluation proposed: (1) efficacy; (2) "real-world" effectiveness; (3) process evaluation; or (4) effectiveness in the context of wider context and systems. High-quality evaluation includes efficacy and process evaluation, stakeholder involvement, consideration of wider context and systems, and economic evaluation
	Evidence translation and implementation in behavior change	Chapters 23, 24; Damschroder et al. (2009); Glasgow et al. (1999); Logan & Graham (2010)	Concepts: implementation science; implementation theories; evidence-based frameworks; translational research Theories/models: the Ottawa model of research use; consolidated framework for implementation research; RE-AIM framework	Beyond efficacy and effectiveness, demonstrable evidence for the translation and implementation of behavior change interventions in "real-world" contexts is needed. Implementation science provides models for translation to ensure optimal engagement and efficacy within the populations, contexts, and settings targeted by the intervention
Considerations in developing behavior change interventions	Involving stakeholders and user engagement	Chapters 21, 22, 24, 25; Glasgow et al. (1999); May et al. (2007); Skivington et al. (2019)	Concepts: tailoring; needs assessment; user attitudes and beliefs; person-based approach; intervention co-design; patient and public involvement Theories/models: normalization process theory; RE-AIM framework; UK Medical Research Council's	Efficacy and effectiveness of behavior change interventions can be optimized by maximizing user engagement and engaging relevant stakeholders in the design process. Tailoring intervention content to the target population based on data collected during development and involving stakeholders such as

Continued

Table 46.1 (Cont.)

Global Theme	Theme	Key Chapters and Citations	Key Concepts/Theories	Significance for Behavior Change
			(MRC) guidance on complex interventions	patients and health professionals in the intervention development process will promote uptake among users and "real-world" effectiveness
	Addressing disparities	Chapter 27; Engel (1977); Kreuter et al. (2003); McLeroy et al. (1988); Myers (2009); Resnicow et al. (1999)	Concepts: inequity; social disparities; socioeconomic status; culturally appropriate models Theories/models: social ecological model; biopsychosocial model; minority stress model; model of cultural sensitivity; model of culturally tailored health communications	Observed disparities in behavior change necessitates a full understanding of the mechanisms that underpin disparities and how they can be addressed. Research and practice in behavior change needs a stronger focus on equity issues and the development of behavior change interventions that are sensitive to culture and socioeconomic inequities
Innovative methods	Qualitative and critical approaches	Chapter 30; Hargreaves (2011); Lyons & Chamberlain (2017)	Concepts: qualitative methods; critical perspectives; social context Theories/models: social practice theory	Traditional theories and models applied to behavior change tend to focus on unitary, individualized explanations of behavior change, and fail to adequately account for contextual and experiential influences. Qualitative approaches offer an alternative that takes into account that behaviors are contextualized, complexly situated, and socially and culturally enabled and patterned
	Use of technology to	Chapters 29, 37, 43; de Bruin et al. (2012);		Interventionists can leverage digital tools, mobile devices, and web- and

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	change behavior	Heber et al. (2017); Webb et al. (2010); Harkin et al. (2016)	Concepts: digital tools and devices; mobile technology; eHealth; apps; web-based interventions Theories/models: theories of self-regulation; integrated self-control theory; tailoring and digital coaching	online-based interventions to deliver tailored interventions, collect detailed real-time behavioral data, and allow for effective behavioral monitoring. Such interventions are cost-effective, have wide support, improve reach and precision of intervention delivery, and are increasingly supported by research. More systematic research is needed, and concerns surrounding data protection and selection of appropriate technology and intervention models need to be addressed

the theories reviewed in Part I. Many of the theories focus on the roles that socially defined intrapersonal beliefs, motives, and states play in determining behavior change, consistent with the social cognition approach (Conner and Norman, 2015). While these theories have made important contributions to understanding behavior change, the emphasis on individual theories highlights the relative dearth of broader perspectives that encompass group, social, ecological, and political determinants, and there have been calls for greater application of social theories (Moore, Cambon et al., 2019). Numerous alternatives to these predominantly individual approaches are also covered in the handbook, such as social identity theory (Tajfel & Turner, 1986; Chapter 16, this volume) and ecological and community models (Bronfenbrenner, 1977; Chapters 17 and 18, this volume). In addition, approaches emphasizing the importance of incorporating social demographic factors into explanations of behavior change, such as socioeconomic status and disparities, are also included (Chapter 27, this volume). However, interventions based on these broader approaches are relatively sparse and warrant greater attention (Chapters 43 and 44, this volume). Other perspectives that encompass these broader factors have been proposed (e.g., Borland, 2017; Johnson et al., 2010), and more research is required on how applications of such approaches can yield more comprehensive explanations of behavior change beyond theories that focus on individual determinants.

46.2.2 Clarity in Specifying and Operationalizing Theories

An important issue arising from research on behavior change theories is the large number of theories available and the considerable variability in the quality of their descriptions of predictions (Davis et al., 2015; Michie, Carey et al., 2017; West et al., 2019). While many theories have good internal validity and clarity in their specifications and predictions, others do not, making it difficult to establish the extent to which the theory is applicable and testable across behavior change contexts. A further issue is the vast number of constructs and mechanisms identified, which presents considerable challenges in synthesizing research on theories and identifying commonalities and redundancies across theories (Hagger, 2014; Michie et al., 2014). A related issue is the lack of clarity in describing the causal mechanisms that underpin relations among theory constructs (West et al., 2019). Further, few theory comparisons demonstrate the relative effectiveness of theories and predictions (e.g., Dzewaltowski, Noble, & Shaw, 1990; Weinstein, 1993), and few attempt to integrate and reconcile constructs and predictions across theories (Hagger, 2009; Rhodes, McEwan, & Rebar, 2019; Chapter 15, this volume).

One solution to the issue of variability in theory specification is the development and application of reporting standards for describing theories. Such standards would entail the development of a common terminology or system to formally specify theories. For example, one research team is developing a set of formal terms and symbols based on systems theory to describe theories (West et al., 2019). Another approach is to develop formalized descriptions of theories using computational modeling (Fried et al., 2019), which can provide systematized descriptions of theory predictions that also encompass auxiliary assumptions and conditions on which the predictions depend (Trafimow, 2012). It is also important to develop standards to evaluate the quality of a theory in terms of its clarity and precision in description and potential to provide hypotheses that are not only empirically testable but testable using robust designs (Meehl, 1990; Trout, 2004). For example, Davis et al. (2015) have developed a theory quality checklist, which provides a preliminary means to evaluate theory specification and description. Furthermore, the field of behavior change should

consider applying principles from philosophy of science to provide formal mechanistic descriptions of relations among theory constructs (Hedström & Ylikoski, 2010). Such an approach is highly relevant to providing theoretical explanations of how behavior change interventions work in changing behavior and guiding their process evaluation (Sheeran, Klein, & Rothman, 2017). Finally, means to deal with the vast number of constructs and mechanisms, many of which have similar content but different labels, have been developed (Michie et al., 2014). One approach has focused on developing classifications of links between theoretical components and behavior change techniques (Carey et al., 2019; Connell et al., 2019). Such an endeavor entails formal synthesis of constructs across theories alongside taxonomies of behavior change techniques. However, such research is in its relative infancy, and future research that applies such tools to behavior change theories is required to identify a core set of theoretical constructs and mechanisms capable of optimally explaining behavior change.

46.2.3 Beyond Silos: The Need for More Multidisciplinary Research

This handbook illustrates the broad diversity in approaches to behavior change (see Table 46.1). The emerging science of behavior change has been informed by research and practice in traditional social science disciplines such as psychology, sociology, economics, and philosophy. However, comparatively new disciplines have also contributed to this understanding, including behavioral economics, behavioral medicine, translational medicine, and implementation science (e.g., Chapters 23 and 42, this volume). The diversity in approaches illustrates the intense interest in behavior change and a recognition that multiple disciplines can contribute to the development of behavioral solutions to many problems in society. Furthermore, an interdisciplinary approach to behavior change could be considered a strength as leveraging methods and strategies across disciplines may afford novel solutions (see Spotswood, 2016). However, it is also clear that much of the research on behavior change tends to be conducted with relatively little interdisciplinary collaboration. Such "siloed" perspectives may impede progress in developing precise, comprehensive explanations of behavior and behavior change interventions.

Nevertheless, there are good examples where an interdisciplinary approach has been effective in advancing knowledge of behavior change. For example, some perspectives on the development and implementation of behavior change interventions combine theory from psychology with design elements from translational medicine and implementation science (e.g., Chapters 21 and 23, this volume). However, such perspectives are relatively rare and there is a need to further facilitate initiatives in which teams from different disciplines collaborate on addressing priority issues on behavior change. For example, the Behavioral Medicine Research Council was founded by a multidisciplinary consortium of organizations including the American Psychological Association's Society for Health Psychology (SfHP), the Academy of Behavioral Medicine Research (ABMR), the American Psychosomatic Society (APS), and the Society for Behavioral Medicine (SBM). The organization aims to identify research priorities and promote strategic goals for behavioral medicine research, of which behavior change is a key element (Freedland, 2019). Similarly, the Science of Behavior Change Research Network is a consortium of research organizations funded by the US National Institutes of Health that brings together basic and applied scientists from different disciplines to conduct research on behavior change. The consortium focuses on developing a better understanding of mechanisms and behavioral interventions in health contexts (National Institutes of Health, 2019) and has published a set of meta-reviews of current evidence on behavior change

interventions and their mechanisms of action (Hennessy et al., 2020; Suls et al., 2020; Wilson et al., 2020). These collaborative initiatives provide models for multidisciplinary research on behavior change that may facilitate novel solutions to behavior-related problems.

46.3 Issues in Behavior Change Intervention Development, Implementation, and Evaluation

46.3.1 Intervention Fidelity

Fidelity is a key determinant of intervention efficacy (Bellg et al., 2004; see Chapters 21 and 22, this volume). Intervention fidelity focuses on whether the intervention components (e.g., intervention content such as messages and behavior change techniques) are delivered to the target population in the intended manner or, if the intervention is self-administered, whether the recipient carries out the intervention according to protocol. Bellg et al. (2004) indicate that fidelity applies to multiple aspects of behavioral interventions: study design, provider training, treatment delivery, treatment receipt, and enactment of treatment skills. Fidelity has been identified as a key moderator of behavior change intervention efficacy in meta-analyses of randomized controlled trials (Durlak & DuPre, 2008; Hardeman et al., 2007). However, research suggests that intervention fidelity is a neglected aspect, with few behavioral intervention trials incorporating procedures to ensure adequate fidelity and measures to assess fidelity. Furthermore, many trials that have included fidelity checks have assessed only some aspects of fidelity (e.g., Rixon et al., 2016; Walton et al., 2017). These deficiencies occur despite the existence of frameworks to guide intervention fidelity procedures (Bellg et al., 2004) and the inclusion of intervention fidelity assessments as integral aspects of intervention development approaches (Abraham, 2012; Presseau et al., 2019; see Chapter 21, this volume). As with initiatives to improve reporting of intervention design and content, advocacy to promote greater attention to fidelity issues is needed. In addition, researchers and intervention designers need prompts and guidance on evaluation methods to assess all salient aspects of behavior change intervention fidelity (Toomey et al., 2019).

46.3.2 New Approaches to the Translation, Feasibility, and Optimization of Behavior Change Interventions

Findings from basic and applied research on behavior change indicate that interventions based on behavioral theory have considerable promise in addressing key behavior-related problems (Bartholomew & Mullen, 2011; Rhodes et al., 2019). However, there is, by comparison, relatively little research on the translation of these findings into workable interventions (often referred to as "Phase III" trials) that can be tested for effectiveness in ecologically valid, "real-world" settings. Increasing emphasis is being placed on processes and systems that outline how behavior change interventions with demonstrable efficacy in experiments and controlled trials can be translated into effective interventions that result in meaningful changes in target populations. Various models have been proposed that describe best-practice steps in translating the evidence base of behavior change interventions into workable behavior change solutions in real-world contexts, such as the Ottawa model of research use (Logan & Graham, 2010), the consolidated framework for implementation research (Damschroder et al., 2009), and the RE-AIM framework (Glasgow, Vogt, & Boles, 1999). Much of this work is informed by relatively new interdisciplinary fields such as translational medicine and implementation studies (see Chapter 23, this volume). Other frameworks have also been

proposed, such as the ORBIT model aimed at developing behavioral interventions in chronic disease (Czajkowski et al., 2015). To date, however, translational activities have seldom been incorporated into behavior change intervention development protocols.

In addition, utilization of innovative research designs focused on translation and real-world application in the early stages of intervention development has been advocated. For example, there have been calls for early-phase translational science practices as a routine part of intervention development. The ORBIT model, for example, offers step-by-step guidance for the development of translatable behavioral interventions, which includes key milestones for progression of intervention design and testing, with options to return to earlier stages for further refinement, feasibility testing, and optimization. The model proposes innovative study methods which, if used early in intervention development, may facilitate translation and optimization later down the track. These methods include human-centered design, behavioral event modeling, small-*N* studies, optimization methods (e.g., dose findings, optimizing treatment findings, developing adaptive treatments), and cluster randomized and pragmatic clinical trials (Naar, Czajkowski, & Spring, 2018). Utilization of such methods may yield more efficient interventions that are optimally effective for the desired context and target population. These procedures are relatively new, however, and few examples of behavior change interventions utilizing these designs exist. Research is needed to determine whether systematic adoption of these methods produces interventions that are optimally effective in evoking meaningful changes in behavioral outcomes in real-world settings.

46.3.3 Ethical Issues in Behavior Change

The ethics underpinning behavior change campaigns and initiatives is an important but seldom considered issue. For example, should governments and organizations implement means and strategies to change the behavior of a population? It is often assumed that the benevolent motives underpinning behavioral interventions, along with the substantive gains in terms of ameliorating problems faced by society, outweigh the moral and ethical concerns relating to freedom to choose and individual rights. However, such issues are rarely raised or debated. Interventions that change behavior through legislation and regulation (e.g., seatbelt use in motor vehicles, bans on tobacco smoking in public places, compulsory safety helmets for cyclists) are usually the consequence of overwhelming evidence supporting the benefits of the behavior, as well as years of lobbying work and political advocacy. Strong support for the legislation in public opinion polls is also important to allay politicians' concerns over introducing unpopular measures. In the face of such universal public support, ethical concerns over personal freedoms become less imperative. Behavior change science could be used to help increase public acceptability of initially unpopular policies, such as various restrictions to tackle climate change (Marteau, 2017).

Although legislation and regulation can be highly effective means to change behavior, they are often not possible, feasible, or sufficiently acceptable to be implemented and often do not have universal support. Other approaches may be necessary, including campaigns aimed at altering behavior through persuasion or other means. Nudge and choice architecture interventions are relatively recent approaches to behavior change (see Chapters 14 and 42, this volume). Such interventions are consistent with the philosophy of "liberal paternalism": While they aim to change behavior by directing individuals toward a particular behavioral response, they do not negate individuals' right to choose. Similarly, information campaigns that seek to persuade individuals to alter their behavior, or offer incentives to do so, do not undermine these rights. However, the

ethics of exposing individuals to particular choice scenarios or messages aimed at altering thought and behavior patterns still demands consideration. Furthermore, interventions that aim to change behavior at the population level can differentially affect certain segments of the population (see Chapter 27, this volume). For example, regulation strategies aimed at manipulating behavior through price increases, such as minimum prices for alcohol and taxes on sugar-sweetened beverages, can disproportionately affect individuals and families on lower incomes (Cawley et al., 2019; Ward, 2011). Given evidence that those on lower incomes are also most affected by the problems associated with the target behavior, this creates a moral dilemma for those tasked with developing and implementing such initiatives.

Ethical considerations should be considered an important "meta-issue" pervading all aspects of behavior change. In the context of research, it is imperative that all trials of behavior change interventions are subjected to rigorous review by experts on ethics through institutional review boards, human research ethics committees, or similar organizational units. Such review primarily focuses on supporting participants' ethical rights to choose – particularly in withdrawing from a trial or declining to engage in specific behaviors or assessment components without prejudice or cost – and on making decisions to approve trials by balancing the potential value and benefits of the research against the costs to participants. More broadly, development of behavior change interventions should involve user groups, that is, representative members of the target population, from the outset and include questions regarding the acceptability of the intervention from the standpoint of intrusion and personal choice (see Chapters 24 and 25, this volume). Similarly, interventionists should consider surveying the target population on the acceptability of introducing the intervention broadly in that community. Such work can assist in identifying potential ethical issues and potential means to address such concerns in the population before the intervention has been developed and implemented. Ethical considerations should, therefore, form a routine part of the developmental procedures of behavior change interventions (see Chapter 21, this volume).

46.3.4 Evaluation of Mechanisms of Impact

Behavior change interventions are predominantly evaluated through examination of effects on the primary outcome (e.g., changes in measures of behavior), while process evaluation is less frequently evaluated (see Chapter 22, this volume). Testing the mechanisms by which interventions lead to behavior change is an important component of process evaluation. Psychological constructs derived from behavioral theory are examples of process-related variables that have been proposed to explain or *mediate* effects of behavior change interventions on behavior. Changes in these constructs reflect the process or *mechanism of action* by which the behavior change technique(s) that comprise the intervention leads to change in the target behavior (see Chapters 19 and 20, this volume).

Numerous authors make reference to a basic process model or theory of change (Sheeran et al., 2017 Hagger et al., 2020; Chapters 20 and 22, this volume; see Figure 46.1), which summarizes the relevant relations necessary for a process evaluation of interventions: (1) the effect of the behavior change technique on the theory-derived construct implicated in the mechanism (path a, Figure 46.1); and (2) the effect of the construct on behavior change (path b, Figure 46.1); and (3) the effect of the technique on behavior change, which represents the residual effect of the intervention independent of the indirect effect through the mediator (path c', Figure 46.1). The indirect effect of the intervention content on behavior change through the theoretical construct represents the mechanism of action of the intervention. A process evaluation of a behavior change intervention necessitates specification of a

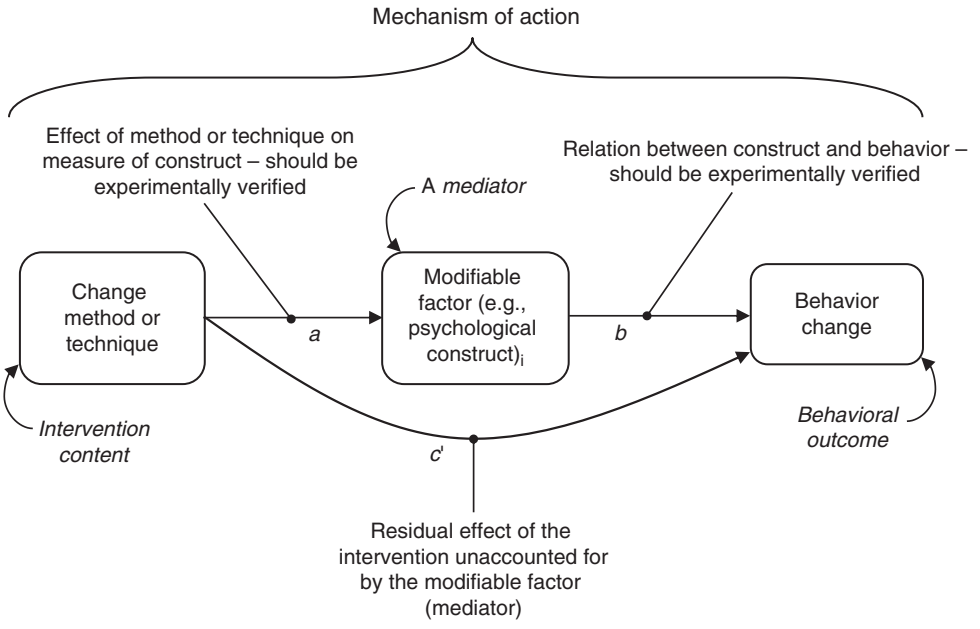

Figure 46.1 A basic model of a behavior change mechanism of action

process model, which will likely form part of the program theory or logic model of the intervention (Chapters 19 and 21, this volume). The mechanism is usually tested using *mediation* analyses, which test the extent to which the effect of change technique on behavior is "transmitted" through the theory-based construct (for more details see Hagger et al., 2020). In practice, the model is likely to be more elaborate because techniques change behavior through more than one construct, different individuals may change via different pathways, and interventions often comprise multiple techniques. However, the basic model provides a template for informing research that will contribute to an evidence base for behavior change techniques, the constructs they are purported to change, and change in behavior.

Despite a growing literature on the importance of identifying mechanisms of action of behavior change interventions, evaluations of mechanisms of change are relatively rare. Many intervention reports do not specify a theoretical framework for the intervention (Michie, Carey et al., 2017; Prestwich et al., 2014), and among those that do, few provide clear descriptions of the mechanisms of action. Among intervention trials that do measure theory-based constructs, relatively few conduct mediation analyses to test the process or conduct an a priori statistical power analysis ensuring that such process evaluation is feasible (Hennessy et al., 2020). In addition, mediation analyses that test intervention effects on behavior change through intermediate or interim measures of the theory-based mediator can be suboptimal to test the mechanism of change (Bullock, Green, & Ha, 2010; Fairchild & McDaniel, 2017). Instead, such analyses should estimate the indirect effect of the intervention on behavior change through *change* in the mediator itself (e.g., Renner et al., 2012). Research syntheses can contribute to knowledge of behavior change mechanisms of action. For example, Rhodes et al. (2020) conducted a meta-analysis of theory-based behavior change interventions in physical activity in which they tested the effects of intervention content on behavior change through the putative constructs implicated in the

theory-based mechanisms of action. This study provides a template for future syntheses of evidence on mechanisms of action and will contribute to future databases on how interventions work in changing behavior. A clear recommendation arising from this handbook is the imperative for researchers and interventionists to incorporate such process evaluations of behavioral interventions from the outset, and including analyses of the mechanisms of impact will advance the evidence base on the mechanisms involved in behavior change interventions.

One barrier to process evaluation is the lack of formal terminology and descriptions linking theory constructs with the behavior change technique purported to change them as well as an appropriate means to describe them. To address this gap, researchers have proposed expert-verified links between theory components and behavior change techniques based on published theories and the development of formal systems to describe those links (Carey et al., 2019; Connell et al., 2019). This work is part of broader projects (e.g., the Theories and Techniques of Behaviour Change Project and the Human Behaviour Change Project) aimed at developing ontological descriptions of behavior change interventions that comprise organized sets of relations between behavior change methods; theoretical techniques; intervention design components (e.g., means of delivery); features of the behavior, context, and population; and behavioral outcomes (Larsen et al., 2016; Michie, Aonghusa et al., 2019; Michie & Johnston, 2017; Michie, Rothman et al., 2019; Michie, Thomas et al., 2017). One of the aims of the projects is to develop a database of behavior change ontologies that is regularly modified and refined as new evidence emerges through machine learning. The database will enable researchers and interventionists to search for the specific sets of techniques, mechanisms of action, and intervention components that can inform the development and process evaluation of interventions.

46.3.5 Complex Systems and Behavior Change Interventions

The complex systems approach is an emerging theme identified in many chapters of this handbook. Numerous authors have noted that behavior change interventions are not only complicated but also complex (Hawe, Shiell, & Riley, 2009; Moore, Evans et al., 2019). Complicated interventions may involve numerous interacting components but still can be divided into discrete sets of actions with predictable, stable, and linear consequences. However, many interventions are better defined as complex due to the emergent, unpredictable, and nonlinear associations between actions and outcomes. Humans are active agents, whose behavior continuously adapts in response to feedback from one another, and individuals' behaviors are part of broader small group and community systems (Moore, Evans et al., 2019). Ideally, behavior change theory, interventions, and evaluations would take such aspects into account, including recursive causality (with reinforcing loops); disproportionate, nonlinear relationships ("tipping points"); and emergent outcomes (Rogers, 2008). This approach challenges the current mainstream view on behavior change interventions, where theories typically assume causal pathways with separate components, usually hypothesized to be linearly associated (see Figure 46.1 for an example). In the mainstream, psychological constructs are thought to be reducible to a set of independent components (component-dominant dynamics; Wallot & Kelty-Stephen, 2018). In the complex systems approach, the alternative view of causality assumes that consecutively measured values of a behavioral or physiological process are *interdependent* and irreducible to component parts (interaction-dominant dynamics). Thus far, available statistical approaches are limited in terms of their capacity to model complexity, so researchers have tended to study behavior with a toolbox of primarily linear methods (Wallot & Kelty-

Stephen, 2018), but novel methods to evaluate mechanisms of behavior change appreciating its complex properties have emerged (Heino et al., 2019). In future, researchers are likely to further explore how complex systems theory can be utilized to better understand behavior change.

46.4 Considerations for "Best Practice" in Behavior Change

46.4.1 Other Intervention Approaches

A major goal of this handbook is to provide up-to-date, evidence-based, practical guidance on how to develop behavior change interventions. To this end, chapters in Part III provide broad coverage of prominent and emerging approaches to behavior change, with accompanying guidance on how to implement them. The approaches were selected on the basis of their prominence, frequency of use, and evidence base underpinning their use. However, it is important to note that some approaches have not been covered. Examples include mental contrasting (Oettingen, 2012) and cognitive behavioral therapy (CBT; Kendall & Hollon, 1979), both of which are briefly summarized here.

Mental contrasting. Mental contrasting is a self-regulation technique in which individuals are prompted to visualize their desired future with respect to a given behavior or outcome and contrast it with their current state, identify obstacles responsible for the discrepancy, and put into place goals or behavioral strategies to overcome the obstacles to the desired outcome (Oettingen, 2012). A recent meta-analytic review of twelve studies applying mental contrasting interventions suggests that it can change health behaviors with small-to-medium effect sizes (Cross & Sheffield, 2019). As a relatively nascent strategy that extends techniques such as mental imagery and goal setting, it has not received full coverage in this handbook beyond a cursory mention (Chapter 33, this volume).

CBT. CBT is a widely used strategy that aims to assist individuals in managing psychological disorders and maladaptive behaviors by challenging and negating maladaptive beliefs and cognitions and developing problem-specific, goal-directed alternatives to the maladaptive behaviors (Kendall & Hollon, 1979). CBT comprises multiple techniques such as cognitive restructuring and goal setting. CBT has a long history and vast evidence base supporting its effectiveness (Butler et al., 2006; Tolin, 2010) but it is not covered in this handbook because of its predominant focus on the management of disorders in clinical populations rather than on behavior change more broadly.

46.4.2 Behavior Change Maintenance

A key challenge facing interventionists is maintaining behavior change over time. Given that long-term maintenance is often requisite for adaptive outcomes to be realized (e.g., improvements in health, educational, environmental, and occupational outcomes), long-term evaluations of behavior maintenance and behavioral outcomes are paramount for interventions to be fit-for-purpose in offering solutions to problems. Many behavior change interventions have demonstrated efficacy and effectiveness in changing behavior in the short and medium term up to a few months post-intervention. However, relatively few intervention trials have demonstrated long-term maintenance of behavior change over many months or years. In many cases, issues around maintenance remain among the "unknowns" in the evidence base for behavior change interventions (Hagger et al., 2020), typically because time and budget constraints do not permit assessment of long-term (e.g., more than one year) maintenance. Researchers and stakeholders interested in behavior change maintenance should lobby research funders to provide sufficient resources for longitudinal intervention trials that can capture maintenance. In addition, interventionists must provide a clear rationale for evaluating behavior change maintenance when applying for research funds and a protocol on how they will do so in funding applications.

Resource availability for intervention components that promote behavior change maintenance is another key consideration. Interventions that aim for maximum efficacy in initiating behavior change are often complex and elaborate and therefore demand considerable resources, particularly human resource costs when the intervention is delivered in person (e.g., interactive client-practitioner sessions, group sessions). The allocation of intensive resources to behavior initiation is understandable, particularly in light of evidence that the length and dosage of behavior change interventions have been found to influence effectiveness (e.g., Burke, Arkowitz, & Menchola, 2003; Gillison et al., 2015). Consequently, however, interventionists may need to consider low-cost alternatives for assisting maintenance of behavior change, especially given that maintenance may not require the intensive methods used to initiate behavior change in the first place (e.g., Burke et al., 2003). Intervention designers can leverage alternatives such as digital and technology-based methods that deliver intervention content (e.g., "booster" messages, behavior monitoring) without the high costs associated with in-person delivery (Webb et al., 2010; see also Chapter 29, this volume). Such technologies may allow for extended delivery of intervention content to the target population and assist in maintaining intervention effects. Another alternative is to tap into existing alternative networks to deliver interventions involving professionals (e.g., health care professionals, community campaigners and leaders) who can be trained to deliver behavior change interventions. The development and evaluation of such alternatives for promoting maintenance, along with the need for long-term evaluations of behavior maintenance, should be priorities for future research.

46.4.3 Education and Training on Behavior Change

As behavior change becomes a priority for organizations aiming to develop solutions to many societal problems, training in the theories, principles, and practices of behavior change has become an integral part of the educational programs of many disciplines (e.g., psychology, sociology, economics) and professions (e.g., medicine, nursing, general practice, occupational management). Training in the science of behavior change is important to produce the next generation of researchers tasked with advancing knowledge of behavior change theory and practice. Behavior change should therefore become a key component of undergraduate and graduate degree programs for these disciplines. Further, training practitioners in multiple professions in the key principles of behavior change is essential to ensure their practice is evidence-based and consistent with the latest research and recommendations. Those tasked with providing in-service training of professionals whose jobs involve changing the behavior of clients need to incorporate training on behavior change practices. Such training should also be included in continuing professional development and top-up courses for qualified professionals whose purview includes changing the behavior of others (e.g., public health specialists and campaign managers, local government policy makers).

The Handbook of Behavior Change can inform the content of behavior change training courses and serve as a reference for the latest evidence-based practices in behavior change. The three parts of the handbook offer a useful template for the development of academic training programs on the theory and evidence-based for behavior change as well as vocational and practice-based training on how to conduct and implement behavior change interventions. In addition, the multiple viewpoints presented in the chapters illustrate the diversity in the scientific disciplines that have been applied to understand behavior change and offer students a rounded, balanced perspective on the subject.

Educators developing behavior change training programs and students of behavior change should also consult the many other resources on behavior change available that will augment and enrich learning. From a scientific perspective, cutting-edge

research and evidence-based practice on behavior change are published in peer-reviewed publications in fields such as applied psychology, social science, translational medicine and implementation science, and behavioral economics (for examples, see Appendix 46.1). One of the optimal ways of identifying these publications is to use search engines (e.g., Google Scholar, Microsoft Academic) or databases (e.g., Web of Science, Scopus, PubMed) using relevant keywords. A further way of learning about recent developments in behavior change is to attend relevant scientific meetings, where scholars can be exposed to the latest research from scientists conducting research in behavior change. These scientific meetings also have special topics and interest groups relevant to behavior change, such as the Theories and Techniques of Behavior Change Interventions special interest group of the Society for Behavioral Medicine and the Intervention Science: Harnessing Psychology to Address Real-World Social Problems pre-conference of the Society of Personality and Social Psychology. In addition, scientists, students, and practitioners of behavior change may consider joining learned societies that represent key disciplines that conduct and promote work in behavior change such as applied psychology (e.g., International Association for Applied Psychology, Society for Personality and Social Psychology, Society for Health Psychology), behavioral medicine (e.g., International Society of Behavioral Medicine, Society of Behavioral Medicine), and motivation (e.g., Society of the Study of Motivation).

Educators and scholars interested in the practice of behavior change within organizations should consider resources designed to train practitioners in behavior change such as the *Improving Health: Changing Behavior – NHS Health Trainer Handbook* (Michie et al., 2008). Further resources that could inform curricula on behavior change include major initiatives conducting large-scale research work and evidence syntheses on behavior change, including the Science of Behavior Change Research Network (SOBC, 2019); the Human Behavior Change Project (Michie, Aonghusa et al., 2019); the Behavioral Medicine Research Council (Freedland, 2019); and the Behavioral Research Program of the National Cancer Institute's Division of Cancer Control and Population Sciences (BRP, 2019).

To date, however, there are no definitive materials or guidelines on the content of behavior change training courses and educational curricula in behavior change. The future of education on behavior change may lie in the development of common content that comprises expert-validated core and elective topics on behavior change. Such validated content will lead to more consistent, uniform training in behavior change and is the hallmark of a maturing discipline of study. The scientific community and learned bodies in behavior change have a key role to play in the development of such core curricula and this should be considered a future goal of this emerging science.

46.5 Conclusion

Recognition of the behavioral origins of many problems in society today has led to a proliferation of interest and research in behavior change. Developing means to understand behavior change and design effective methods to change behavior is a priority agenda for governments and policy makers, research organizations and funders, and practitioners in multiple fields and disciplines. The increased emphasis placed on research inquiry and practice on behavior change is founded on the premise that changing behavior has been shown to offer effective solutions to many societal problems but has also been shown to be cost-effective. This chapter has identified key emerging issues and priority research directions arising from the handbook. From the perspective of theory development, there is a need for (1) a move away from individual theories and toward more integrative approaches that encompass social and ecological determinants of action; (2) clearer specification and operationalization of

behavior change theories; and (3) more interdisciplinary as opposed to siloed approaches to behavior change. In terms of behavior change intervention development, future research should consider (1) conducting more comprehensive and consistent evaluations of intervention fidelity; (2) utilizing innovative research methods, particularly in the design phase, for more effective translation, feasibility, and optimization of interventions; (3) ensuring ethical considerations are taken into account in the development and implementation of interventions; (4) conducting evaluations of the mechanisms of action of behavior change interventions; and (5) adopting a complex systems approach as an alternative paradigm in the development and evaluation of behavior change interventions and theories. In addition, ongoing development of behavior change intervention "best practice" should consider (1) broadening the scope to encompass approaches to behavior change from other disciplines; (2) evaluating the efficacy and effectiveness of interventions to produce long-term maintenance of behavior; and (3) developing core educational curricula to train the next generation of behavior change specialists. The growing interest in behavior change, and the research intensiveness in the field, suggests that the emerging science of behavior change is in good health and will continue to develop. *The Handbook of Behavior Change* represents a culmination of current work behavior change that can not only serve to provide a broad overview of theory and practice in this emerging science but also set the agenda for future research inquiry toward the development of optimal behavioral solutions to problems in society.

References

Abraham, C. (2012). Mapping change mechanisms onto behaviour change techniques: A systematic approach to promoting behaviour change through text. In C. Abraham & M. Kools (Eds.), *Writing Health Communication: An Evidence Based Guide* (pp. 99–116). Thousand Oaks, CA: SAGE.

Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, *50*, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Bandura, A. (1986). *Social Foundations of Thought and Action: A Social-Cognitive Theory.* Englewood Cliffs, NJ: Prentice Hall.

Bartholomew, L. K., & Mullen, P. D. (2011). Five roles for using theory and evidence in the design and testing of behavior change interventions. *Journal of Public Health Dentistry*, *71*, S20–S33. https://doi.org/10.1111/j.1752-7325.2011.00223.x

Bartholomew Eldredge, L. K., Markham, C. M., Ruiter, R. A. C., Fernández, M. E., Parcel, G. S., & Kok, G. (2016). *Planning Health Promotion Programs: An Intervention Mapping Approach* (4th ed.). San Francisco, CA: Jossey-Bass.

Bellg, A. J., Borrelli, B., Resnick, B. et al. (2004). Special NIH committee report – Enhancing treatment fidelity in health behavior change studies: Best practices and recommendations from the NIH behavior change consortium. *Health Psychology*, *23*, 443–451.

Borland, R. (2017). CEOS theory: A comprehensive approach to understanding how to maintain behaviour change. *Applied Psychology: Health and Well-Being*, *9*, 3–35. https://doi.org/10.1111/aphw.12083

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*, 513–531. https://doi.org/10.1037/0003-066X.32.7.513

BRP (Behavioral Research Program). (2019). Behavioral Research Program of the National Cancer Institute's Division of Cancer Control and Population Sciences. Website. https://cancercontrol.cancer.gov/brp/about.html

Bullock, J. G., Green, D. P., & Ha, S. E. (2010). Yes, but what's the mechanism? (don't expect an easy answer). *Journal of Personality and Social Psychology*, *98*, 550–558. https://doi.org/10.1037/a0018933

Burke, B. L., Arkowitz, H., & Menchola, M. (2003). The efficacy of motivational interviewing: A meta-analysis of controlled clinical trials. *Journal of Consulting and Clinical Psychology*, *71*, 843–861. https://doi.org/10.1037/0022-006x.71.5.843

Butler, A. C., Chapman, J. E., Forman, E. M., & Beck, A. T. (2006). The empirical status of cognitive-behavioral therapy: A review of meta-analyses. *Clinical Psychology Review*, *26*, 17–31. https://doi.org/10.1016/j.cpr.2005.07.003

Carey, R. N., Connell, L. E., Johnston, M. et al. (2019). Behavior change techniques and their mechanisms of action: A synthesis of links described in published intervention literature. *Annals of Behavioral Medicine*, *53*, 693–707. https://doi.org/10.1093/abm/kay078

Cawley, J., Thow, A. M., Wen, K., & Frisvold, D. (2019). The economics of taxes on sugar-sweetened beverages: A review of the effects on prices, sales, cross-border shopping, and consumption. *Annual Review of Nutrition*, *39*, 317–338. https://doi.org/10.1146/annurev-nutr-082018-124603

Connell, L. E., Carey, R. N., de Bruin, M. et al. (2019). Links between behavior change techniques and mechanisms of action: An expert consensus study. *Annals of Behavioral Medicine*, *53*, 708–720. https://doi.org/10.1093/abm/kay082

Conner, M. T., & Norman, P. (2015). Predicting and changing health behaviour: A social cognition approach. In M. T. Conner & P. Norman (Eds.), *Predicting and Changing Health Behaviour: Research and Practice with Social Cognition Models* (3rd ed., pp. 1–29). Maidenhead: Open University Press.

>Cross, A., & Sheffield, D. (2019). Mental contrasting for health behaviour change: A systematic review and meta-analysis of effects and moderator variables. *Health Psychology Review*, *13*, 209–225. https://doi.org/10.1080/17437199.2019.1594332

Czajkowski, S. M., Powell, L. H., Adler, N. et al. (2015). From ideas to efficacy: The ORBIT model for developing behavioral treatments for chronic diseases. *Health Psychology*, *34*, 971–982. https://doi.org/10.1037/hea0000161

Damschroder, L. J., Aron, D. C., Keith, R. E., Kirsh, S. R., Alexander, J. A., & Lowery, J. C. (2009). Fostering implementation of health services research findings into practice: A consolidated framework for advancing implementation science. *Implementation Science*, *4*, 50. https://doi.org/10.1186/1748-5908-4-50

Davis, R., Campbell, R., Hildon, Z., Hobbs, L., & Michie, S. (2015). Theories of behaviour and behaviour change across the social and behavioural sciences: A scoping review. *Health Psychology Review*, *9*, 323–344. https://doi.org/10.1080/17437199.2014.941722

Daw, N. D., Gershman, S. J., Seymour, B., Dayan, P., & Dolan, R. J. (2011). Model-based influences on humans' choices and striatal prediction errors. *Neuron*, *69*, 1204–1215. https://doi.org/10.1016/j.neuron.2011.02.027

de Bruin, M., Sheeran, P., Kok, G. et al. (2012). Self-regulatory processes mediate the intention-behavior relation for adherence and exercise behaviors. *Health Psychology*, *31*, 695–703. https://doi.org/10.1037/a0027425

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic Motivation and Self-Determination in Human Behavior*. New York: Plenum Press.

Durlak, J. A., & DuPre, E. P. (2008). Implementation matters: A review of research on the influence of implementation on program outcomes and the factors affecting implementation. *American Journal of Community Psychology*, *41*, 327. https://doi.org/10.1007/s10464-008-9165-0

Dzewaltowski, D. A., Noble, J. M., & Shaw, J. M. (1990). Physical activity participation: Social cognitive theory vs. the theories of reasoned action and planned behavior. *Journal of Sport and Exercise Psychology*, *12*, 388–405.

Engel, G. (1977). The need for a new medical model: A challenge for biomedicine. *Science*, *196*, 129–136. https://doi.org/10.1126/science.847460

Fairchild, A. J., & McDaniel, H. L. (2017). Best (but oft-forgotten) practices: Mediation analysis. *The American Journal of Clinical Nutrition*, *105*, 1259–1271. https://doi.org/10.3945/ajcn.117.152546

Freedland, K. E. (2019). The Behavioral Medicine Research Council: Its origins, mission, and methods. *Health Psychology*, *38*, 277–289. https://doi.org/10.1037/hea0000731

Fried, E., Robinaugh, D., Quinn, K., & Tiokhin, L. (2019). Resource list: Formalizing theories in social sciences. https://osf.io/n9zta/

Gibbons, F. X., Gerrard, M., Blanton, H., & Russell, D. W. (1998). Reasoned action and social reaction: Willingness and intention as independent

predictors of health risk. *Journal of Personality and Social Psychology*, *74*, 1164–1180.

Gillison, F. B., Stathi, A., Reddy, P. et al. (2015). Processes of behavior change and weight loss in a theory-based weight loss intervention program: A test of the process model for lifestyle behavior change. *International Journal of Behavioral Nutrition and Physical Activity*, *12*, 2. https://doi.org/10.1186/s12966-014-0160-6

Glasgow, R. E., Harden, S. M., Gaglio, B. et al. (2019). RE-AIM planning and evaluation framework: Adapting to new science and practice with a 20-year review. *Frontiers in Public Health*, *7*. https://doi.org/10.3389/fpubh.2019.00064

Glasgow, R. E., Vogt, T. M., & Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: The RE-AIM framework. *American Journal of Public Health*, *89*, 1322–1327.

Hagger, M. S. (2009). Theoretical integration in health psychology: Unifying ideas and complimentary explanations. *British Journal of Health Psychology*, *14*, 189–194. https://doi.org/10.1348/135910708X397034

Hagger, M. S. (2014). Avoiding the "déjà-variable" phenomenon: Social psychology needs more guides to constructs. *Frontiers in Psychology*, *5*, 52. https://doi.org/10.3389/fpsyg.2014.00052

Hagger, M. S., & Chatzisarantis, N. L. D. (2014). An integrated behavior-change model for physical activity. *Exercise and Sport Sciences Reviews*, *42*, 62–69. https://doi.org/10.1249/JES.0000000000000008

Hagger, M. S., Moyers, S., McAnally, K., & McKinley, L. E. (2020). Known knowns and known unknowns on behavior change interventions and mechanisms of action. *Health Psychology Review*, *14*, 199–212. https://doi.org/10.1080/17437199.2020.1719184

Hardeman, W., Michie, S., Fanshawe, T., Prevost, T., Mcloughlin, K., & Kinmonth, A. L. (2007). Fidelity of delivery of a physical activity intervention: Predictors and consequences. *Psychology and Health*, *23*, 11–24.

Hargreaves, T. (2011). Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture*, *11*, 79–99. https://doi.org/10.1177/1469540510390500

Harkin, B., Webb, T. L., Chang, B. P. I. et al. (2016). Does monitoring goal progress promote goal attainment? A meta-analysis of the experimental evidence. *Psychological Bulletin*, *142*, 198–229. https://doi.org/10.1037/bul0000025

Hawe, P., Shiell, A., & Riley, T. (2009). Theorising Interventions as events in systems. *American Journal of Community Psychology*, *43*, 267–276. https://doi.org/10.1007/s10464-009-9229-9

Heber, E., Ebert, D. D., Lehr, D. et al. (2017). The benefit of web- and computer-based interventions for stress: A systematic review and meta-analysis. *Journal of Medical Internet Research*, *19*, e32. https://doi.org/10.2196/jmir.5774

Heckhausen, H., & Gollwitzer, P. M. (1987). Thought contents and cognitive functioning in motivational and volitional states of mind. *Motivation and Emotion*, *11*, 101–120. https://doi.org/10.1007/BF00992338

Hedström, P., & Ylikoski, P. (2010). Causal mechanisms in the social sciences. *Annual Review of Sociology*, *36*, 49–67. https://doi.org/10.1146/annurev.soc.012809.102632

Heino, M. T. J., Noonan, C., Knittle, K., & Hankonen, N. (2019). Studying behaviour change mechanisms under complexity. Unpublished manuscript, University of Helsinki.

Hennessy, E. A., Johnson, B. T., Acabchuk, R. L., McCloskey, K., & Stewart-James, J. (2020). Self-regulation mechanisms in health behaviour change: A systematic meta-review of meta-analyses, 2006–2017. *Health Psychology Review*, *14*, 6–42. https://doi.org/10.1080/17437199.2019.1679654

Hofmann, W., & Kotabe, H. (2012). A general model of preventive and interventive self-control. *Social and Personality Psychology Compass*, *6*, 707–722. https://doi.org/10.1111/j.1751-9004.2012.00461.x

Jetten, J., Haslam, C., & Haslam, S. A. (Eds.). (2012). *The Social Cure: Identity, Health and Well-Being*. New York: Psychology Press.

Johnson, B. T., Redding, C. A., DiClemente, R. J. et al. (2010). A network-individual-resource model for HIV prevention. *AIDS and Behavior*, *14*, 204–221. https://doi.org/10.1007/s10461-010-9803-z

Kahneman, D. (2011). *Thinking, Fast and Slow.* New York: Farrar, Straus & Giroux.

Kendall, P. C., & Hollon, S. D. (1979). Cognitive-behavioral interventions: Overview and current status. In P. C. Kendall & S. D. Hollon (Eds.), *Cognitive-Behavioral Interventions: Theory, Research, and Procedures* (pp. 1–9). New York: Academic Press.

Kreuter, M. W., Lukwago, S. N., Bucholtz, D. C., Clark, E. M., & Sanders-Thompson, V. (2003). Achieving cultural appropriateness in health promotion programs: Targeted and tailored approaches. *Health Education and Behavior*, *30*, 133–146. https://doi.org/10.1177/1090198102251021

Larsen, K. R., Michie, S., Hekler, E. B. et al. (2016). Behavior change interventions: The potential of ontologies for advancing science and practice. *Journal of Behavioral Medicine*, *40*, 6–22. https://doi.org/10.1007/s10865-016-9768-0

Leventhal, H., Meyer, D., & Nerenz, D. (1980). The common sense model of illness danger. In S. Rachman (Ed.), *Medical Psychology*, Vol. *2* (pp. 7–30). New York: Pergamon Press.

Locke, E. A., & Latham, G. P. (2019). The development of goal setting theory: A half century retrospective. *Motivation Science*, *5*, 93–105. https://doi.org/10.1037/mot0000127

Logan, J., & Graham, I. D. (2010). The Ottawa model of research use. In J. R. M. Bucknall (Ed.), *Models and Frameworks for Implementing Evidence-Based Practice: Evidence to Action* (pp. 83–108). Oxford: Wiley Blackwell.

Lyons, A. C., & Chamberlain, K. (2017). Critical health psychology. In B. Gough (Ed.), *The Palgrave Handbook of Critical Social Psychology* (pp. 533–555). London: Palgrave Macmillan.

Marteau, T. M. (2017). Towards environmentally sustainable human behaviour: Targeting non-conscious and conscious processes for effective and acceptable policies. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, *375*, 20160371. https://doi.org/10.1098/rsta.2016.0371

May, C., Finch, T., Mair, F. et al. (2007). Understanding the implementation of complex interventions in health care: The normalization process model. *BMC Health Services Research*, *7*, 148. https://doi.org/10.1186/1472-6963-7-148

McLeroy, K. R., Bibeau, D., Steckler, A., & Glanz, K. (1988). An ecological perspective on health promotion programs. *Health Education Quarterly*, *15*, 351–377. https://doi.org/10.1177/109019818801500401

Meehl, P. E. (1990). Why summaries of research on psychological theories are often uninterpretable. *Psychological Reports*, *66*, 195–244. https://doi.org/10.2466/pr0.1990.66.1.195

Michie, S., Aonghusa, P. M., Johnston, M. et al. (2019). The Human Behaviour Change Project. Website. www.humanbehaviourchange.org

Michie, S., Carey, R. N., Johnston, M. et al. (2017). From theory-inspired to theory-based interventions: A protocol for developing and testing a methodology for linking behaviour change techniques to theoretical mechanisms of action. *Annals of Behavioral Medicine*, *52*, 501–512. https://doi.org/10.1007/s12160-016-9816-6

Michie, S., & Johnston, M. (2017). Optimising the value of the evidence generated in implementation science: The use of ontologies to address the challenges. *Implementation Science*, *12*, 131. https://doi.org/10.1186/s13012-017-0660-2

Michie, S., Rothman, A. J., Kelly, M., & de Bruin, M. (2019). Theories and techniques of behaviour change project. https://www.ucl.ac.uk/pals/research/clinical-educational-and-health-psychology/research-groups/behaviour-change-techniques-and

Michie, S., Rumsey, N., Fussell, A. et al. (2008). *Improving Health: Changing behaviour – NHS Health Trainer Handbook*. London: Department of Health.

Michie, S., Thomas, J., Johnston, M. et al. (2017). The human behaviour-change project: Harnessing the power of artificial intelligence and machine learning for evidence synthesis and interpretation. *Implementation Science*, *12*, 121. https://doi.org/10.1186/s13012-017-0641-5

Michie, S., van Straalen, M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*, 42. https://doi.org/10.1186/1748-5908-6-42

Michie, S., West, R., Campbell, R., Brown, J., & Gainforth, H. (2014). *ABC of Behaviour Change Theories*. London: Silverback Publishing.

Montaño, D. E., & Kasprzyk, D. (2015). Theory of reasoned action, theory of planned behavior, and the integrated behavioral model. In K. Glanz, B. K. Rimer & K. Viswanath (Eds.), *Health Behavior and Health Education: Theory, Research, and Practice* (5th ed., pp. 95–124). San Francisco, CA: Jossey-Bass.

Moore, G. F., Cambon, L., Michie, S. et al. (2019). Population health intervention research: The place of theories. *Trials*, *20*, 285. https://doi.org/10.1186/s13063-019-3383-7

Moore, G. F., Evans, R. E., Hawkins, J. et al. (2019). From complex social interventions to interventions in complex social systems: Future directions and unresolved questions for intervention development and evaluation. *Evaluation*, *25*, 23–45. https://doi.org/10.1177/1356389018803219

Myers, H. F. (2009). Ethnicity- and socio-economic status-related stresses in context: An integrative review and conceptual model. *Journal of Behavioral Medicine*, *32*, 9–19. https://doi.org/10.1007/s10865-008-9181-4

Naar, S., Czajkowski, S. M., & Spring, B. (2018). Innovative study designs and methods for optimizing and implementing behavioral interventions to improve health. *Health Psychology*, *37*, 1081–1091. https://doi.org/10.1037/hea0000657

National Institutes of Health. (2019). Science of behavior change. Website. https://scienceofbehaviorchange.org/

Oettingen, G. (2012). Future thought and behaviour change. *European Review of Social Psychology*, *23*, 1–63. https://doi.org/10.1080/10463283.2011.643698

Presseau, J., Byrne-Davis, L. M. T., Hotham, S. et al. (2019). *Following through on health behaviour change breakthroughs: The synergy between implementation science and health psychology.* Unpublished manuscript, University of Ottawa, Canada.

Prestwich, A., Sniehotta, F. F., Whittington, C., Dombrowski, S. U., Rogers, L., & Michie, S. (2014). Does theory influence the effectiveness of health behavior interventions? Meta-analysis. *Health Psychology*, *33*, 465–474. https://doi.org/10.1037/a0032853

Renner, B., Hankonen, N., Ghisletta, P., & Absetz, P. (2012). Dynamic psychological and behavioral changes in the adoption and maintenance of exercise. *Health Psychology*, *31*, 306–315. https://doi.org/10.1037/a0025302

Resnicow, K., Baranowski, T., Ahluwalia, J. S., & Braithwaite, R. L. (1999). Cultural sensitivity in public health: Defined and demystified. *Ethnicity and Disease*, 9.

Rhodes, R. E., Boudreau, F., Weman Josefsson, K., & Ivarsson, A. (2020). Mediators of physical activity behavior change interventions among adults: A systematic review and meta-analysis. *Health Psychology Review*. https://doi.org/10.1080/17437199.2019.1706614

Rhodes, R. E., McEwan, D., & Rebar, A. L. (2019). Theories of physical activity behaviour change: A history and synthesis of approaches. *Psychology of Sport and Exercise*, *42*, 100–109. https://doi.org/10.1016/j.psychsport.2018.11.010

Rixon, L., Baron, J., McGale, N., Lorencatto, F., Francis, J., & Davies, A. (2016). Methods used to address fidelity of receipt in health intervention research: A citation analysis and systematic review. *BMC Health Services Research*, *16*, 663. https://doi.org/10.1186/s12913-016-1904-6

Rogers, P. J. (2008). Using programme theory to evaluate complicated and complex aspects of interventions. *Evaluation*, *14*, 29–48. https://doi.org/10.1177/1356389007084674

Rogers, R. W. (1975). A protection motivation theory of fear appeals and attitude change. *Journal of Psychology*, *91*, 93–114. https://doi.org/10.1080/00223980.1975.9915803

Rosenstock, I. M. (1974). Historical origins of the health belief model. *Health Education Monographs*, *2*, 328–335.

Schwarzer, R. (2008). Modeling health behaviour change: How to predict and modify the adoption and maintenance of health behaviors. *Applied Psychology: An International Review*, *57*, 1–29. https://doi.org/10.1111/j.1464-0597.2007.00325.x

Sheeran, P., Klein, W. M. P., & Rothman, A. J. (2017). Health behavior change: Moving from observation to intervention. *Annual Review of Psychology*, *68*, 573–600 https://doi.org/10.1146/annurev-psych-010416-044007

Skivington, K., Matthews, L., Craig, P. et al. (2018). MRC guidance: Developing and evaluating complex interventions. Updating Medical Research Council guidance to take account of new methodological and theoretical approaches. *The Lancet*, *392*, S2. Meeting abstract: Public Health Science 2018, Belfast, Northern Ireland, November 23, 2018. http://dx.doi.org/10.1016/s0140-6736(18)32865-4

SOBC (Science of Behavior Change Research Network). (2019). Science of Behavior Change Research Network.

Spotswood, F. (Ed.). (2016). *Beyond Behaviour Change*. Bristol: Bristol University Press.

Strack, F., & Deutsch, R. (2004). Reflective and impulsive determinants of social behavior. *Personality and Social Psychology Review*, *8*, 220–247. https://doi.org/10.1207/s15327957pspr0803_1

Suls, J., Mogavero, J. N., Falzon, L., Pescatello, L. S., Hennessy, E. A., & Davidson, K. W. (2020). Health behaviour change in cardiovascular disease prevention and management: Meta-review of behavior change techniques to affect self-regulation. *Health Psychology Review*, *14*, 43–65. https://doi.org/10.1080/17437199.2019.1691622

Tajfel, H., & Turner, J. C. (1986). The social identity theory of intergroup behaviour. In S. G. Worchel & W. Austin (Eds.), *Psychology of Intergroup Relations* (2nd ed., pp. 7–24). Chicago: Nelson-Hall.

Thaler, R., & Sunstein, C. R. (2008). *Nudge: Improving Decisions about Health, Wealth, and Happiness*. New Haven, CT: Yale University Press.

Tolin, D. F. (2010). Is cognitive–behavioral therapy more effective than other therapies?: A meta-analytic review. *Clinical Psychology Review*, *30*, 710–720. https://doi.org/https://doi.org/10.1016/j.cpr.2010.05.003

Toomey, E., Hardeman, W., Hankonen, N. et al. (2019). Focusing on fidelity: Recommendations for improving intervention fidelity within trials of health behavioral interventions. https://doi.org/10.13140/RG.2.2.22329.11367

Trafimow, D. (2012). The role of auxiliary assumptions for the validity of manipulations and measures. *Theory and Psychology*, *22*, 486–498. https://doi.org/10.1177/0959354311429996

Triandis, H. C. (1977). *Interpersonal Behavior*. Monterey, CA: Brookes/Cole.

Trout, J. D. (2004). The philosophical legacy of Meehl (1978): Confirmation theory, theory quality, and scientific epistemology. *Applied and Preventive Psychology*, *11*, 73–76. https://doi.org/10.1016/j.appsy.2004.02.013

Turner, J. C., Hogg, M. A., Oakes, P. J., Reicher, S. D., & Wetherell, M. S. (1987). *Rediscovering the Social Group: A Self-Categorization Theory*. Cambridge, MA: Basil Blackwell.

Wallot, S., & Kelty-Stephen, D. G. (2018). Interaction-dominant causation in mind and brain, and its implication for questions of generalization and replication. *Minds and Machines*, *28*, 353–374. https://doi.org/10.1007/s11023-017-9455-0

Walton, H., Spector, A., Tombor, I., & Michie, S. (2017). Measures of fidelity of delivery of, and engagement with, complex, face-to-face health behaviour change interventions: A systematic review of measure quality. *British Journal of Health Psychology*, *22*, 872–903. https://doi.org/10.1111/bjhp.12260

Ward, P. (2011). A minimum price for alcohol? House of Commons Standard Note SN/HA/5021, London.

Webb, T. L., Joseph, J., Yardley, L., & Michie, S. (2010). Using the internet to promote health behavior change: A systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medical Internet Research*, *12*, e4. https://doi.org/10.2196/jmir.1376

Weinstein, N. D. (1993). Testing four competing theories of health-protective behavior. *Health Psychology*, *12*, 324–333. https://doi.org/10.1037/0278-6133.12.4.324

West, R., Godinho, C. A., Bohlen, L. C. et al. (2019). Development of a formal system for representing behaviour-change theories. *Nature Human Behaviour*, *3*, 526–536. https://doi.org/10.1038/s41562-019-0561-2

Wilson, T. E., Hennessy, E. A., Falzon, L., Boyd, R., Kronish, I. M., & Birk, J. L. (2020). Effectiveness of interventions targeting self-regulation to improve adherence to chronic disease medications: A meta-review of meta-analyses. *Health Psychology Review*, *14*, 66–85. https://doi.org/10.1080/17437199.2019.1706615